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(54) [Title of the Invention] LIQUID CRYSTAL DISPLAY PANEL

(57) [Abstract]
[Object]

To suppress generation of uneven contrast or an interference fringe, and to improve display quality.

[Constitution]

A transparent pixel electrode 2 is formed over an opposite transparent substrate 1 and an orientation film 8 is formed thereover, which forms an opposite substrate 3. A transparent pixel electrode 5 is formed over a transparent substrate 4 opposed to the transparent substrate 1 and an orientation film 9 is formed thereover, which forms an element substrate 7. A peripheral gap between both the transparent substrates 1 and 4 is covered with a seal resin 10, and an internal space thereof is filled with a liquid crystal layer 12 with an intra-cell spacer 13 interposed. The seal resin 10 encloses an intra-seal spacer 11 having a uniform diameter. A height control film 14 is formed over the transparent substrate 4 on the element substrate 7 side in a portion where the height of the intra-seal spacer 11 is insufficient, so that a cell gap between both the transparent substrates 1 and 4 opposed to each other is kept uniform over an entire panel by the height control film 14.

[Scope of Claim for Patent]

[Claim 1]

A liquid crystal display panel in which a peripheral gap between a pair of transparent substrates opposed to each other is covered with a seal resin enclosing an intra-seal spacer having a uniform diameter, and an internal space is filled with a liquid crystal layer with an intra-cell spacer interposed, characterized in that a height control film is formed over at least one of the transparent substrates in a portion where the height of the intra-seal spacer is insufficient so as to keep a cell gap between the pair of transparent substrates uniform over an entire panel.

[Claim 2]

A liquid crystal display panel in which a peripheral gap between a pair of transparent substrates opposed to each other is covered with a seal resin enclosing an intra-seal spacer, and an internal space is filled with a liquid crystal layer with an intra-cell spacer interposed, characterized in that a conductive particle having a uniform diameter is mixed into the seal resin to electrically connect the transparent substrates to each other through the conductive particle←OK and also to control an interval between both the transparent substrates.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Application]

The present invention relates to a liquid crystal display panel which is widely used as a display means in various electronic devices.

[0002]

[Related Art]

FIG. 7 shows a cross-sectional shape of an example of a conventional liquid crystal display panel. A color filter layer including a dye, a pigment, or the like is formed over a transparent substrate 1 of glass or the like and a transparent pixel electrode 2 including metal or an alloy such as Indium Tin Oxide ($InSnO_2$: hereinafter described as an ITO film) is formed thereover, which forms an opposite substrate 3. A film of metal or an alloy such as Ta, Ti, Al, or ITO is formed over a transparent substrate 4 opposed to the opposite substrate 3 with a required gap therebetween by a sputtering method or a PCVD (Plasma Chemical Vapor Deposition) method and then etched to form an active element such as a thin film transistor (TFT) or a MIM (Metal Insulator Metal Liquid Crystal), or a transparent pixel electrode 5 and a signal input terminal 6 including a bus

line or the like, which forms an element substrate 7. Orientation films 8 and 9 each including alicyclic polyimide are formed over the transparent pixel electrodes 2 and 5, respectively, to be opposed to each other. A seal resin 10 is interposed as a peripheral wall between a peripheral portion of the transparent substrate 1 and a peripheral portion of the transparent substrate 4 to cover a peripheral gap between a pair of the transparent substrates 1 and 4. A number of intra-seal spacers 11 having a uniform diameter are enclosed in the seal resin 10. Additionally, an internal space surrounded by the transparent substrates 1 and 4 and the seal resin 10 is filled with a liquid crystal layer 12, and an intra-cell spacer 13 is interposed between the orientation films 8 and 9 to keep a cell gap uniform in the liquid crystal layer 12.

[0003]

FIG. 8 is a perspective view showing an example of a conventional active matrix liquid crystal display panel. FIG. 9 is a cross-sectional view along the line d-d of FIG. 8. A peripheral gap between a pair of transparent substrates 21 and 22 such as glass substrates opposed to each other is covered with a seal resin 23 by printing or coating, and an internal space is filled with a liquid crystal layer 24. In order to keep a gap size between both the transparent substrates 21 and 22 (cell gap) uniform over an entire panel, an intra-cell spacer 25 such as a glass fiber or a plastic particle having a uniform diameter is uniformly sprayed between both the transparent substrates 21 and 22 in the liquid crystal layer 24, and an intra-seal spacer 26 such a glass fiber having a uniform diameter is enclosed in the seal resin 23.

[0004]

An electrode of the opposite transparent substrate 21 may be extracted from an opposite electrode 27. However, generally, a signal extraction line 28 is arranged over the matrix side transparent substrate 22, a signal extraction line 29 connected to the opposite electrode 27 is arranged over the opposite transparent substrate 21, and both the signal extraction lines 28 and 29 are connected to each other through an electrical connection member 31 in a line extraction portion 30 where the seal resin 23 is diverted inward. As the electrical connection member 31, silver, Ni, carbon, or the like is used.

[0005]

Note that reference numeral 32 denotes an insulating film; 33 and 34, matrix side electrode lines; 35, a liquid crystal inlet; and 36, a sealing resin for the liquid crystal inlet 35.

[0006]

[Problems to be Solved by the Invention]

In the case of the liquid crystal display panel of FIG. 7, a film structure below the seal resin 10 is different on four sides of the element substrate 7. Nevertheless, all diameters of the intra-seal spacer 11 in the seal resin 10 are uniform. Therefore, a cell gap which is an interval between both the transparent substrates 1 and 4 varies on each substrate side. Accordingly, non-uniformity of a cell gap is caused on a display surface, and uneven contrast or an interference fringe such as Newton ring (NR) is generated, which results in lowering display quality.

[0007]

In the case of the liquid crystal display panel of FIGS. 8 and 9, there is a step of printing or coating with the intra-seal spacer 26 having a uniform diameter mixed into the seal resin 23 to control a cell gap between the transparent substrates 21 and 22. Aside from this, there is another step of connecting the signal extraction lines 28 and 29 to each other by providing the line extraction portion 30 to divert the seal resin 23, coating it with the electrical connection member 31, and the like. Division into two steps as described above is one of causes of preventing productivity improvement.

[0008]

The present invention is made in view of the above circumstances, and it is the first object to suppress the generation of uneven contrast or an interference fringe and to improve display quality. The second object is to improve productivity by reducing the number of steps.

[0009]

[Means to Solve the Problem]

A first liquid crystal display panel according to the present invention is a liquid crystal display panel in which a peripheral gap between a pair of transparent substrates opposed to each other is covered with a seal resin enclosing an intra-seal spacer having a uniform diameter, and an internal space is filled with a liquid crystal layer with an intra-cell spacer interposed, characterized in that a height control film is formed over at least one of the transparent substrates in a portion where the height of the intra-seal spacer is insufficient so as to keep a cell gap between the pair of the transparent substrates uniform over an entire panel.

[0010]

A second liquid crystal display panel according to the invention is a liquid crystal display panel in which a peripheral gap between a pair of transparent substrates opposed to each other is covered with a seal resin enclosing an intra-seal spacer, and an internal space is filled with a liquid crystal layer with an intra-cell spacer interposed,

characterized in that a conductive particle having a uniform diameter is mixed into the seal resin to electrically connect the transparent substrates to each other through the conductive particle and also to control an interval between both the transparent substrates. Note that a conductive particle having a uniform diameter may be also used as the intra-seal spacer, or a conductive particle may be mixed with the intra-seal spacer.

[0011]

[Operation]

According to the first liquid crystal display panel, non-uniformity of a cell gap on a display surface is eliminated, and uneven contrast or an interference fringe is not caused. Note that a thickness of the height control film is preferably set so that a cell gap error is 1000 Å or less in the seal resin part.

[0012]

According to the second liquid crystal display panel, a conductive particle mixed in the seal resin serves to electrically connect the transparent electrodes to each other and to control an interval between the transparent electrodes at the same time; thus, the number of steps is reduced.

[0013]

[Embodiment]

Hereinafter, embodiments of a liquid crystal display panel according to the present invention are described in detail with reference to the drawings.

[0014] Embodiment 1

FIG. 1 is a cross-sectional view schematically showing a structure of a liquid crystal display panel according to Embodiment 1 of the invention. An ITO film (Indium Tin Oxide: $InSnO_2$) is formed over a transparent substrate 1 of glass or the like by a sputtering method and a transparent pixel electrode 2 is formed in a simple matrix by a photolithography method, which forms an opposite substrate 3. An ITO film is formed by a sputtering method over a transparent substrate 4 opposed to the opposite substrate 3 with a certain interval, and a transparent pixel electrode 5 is formed by a photolithography method in a simple matrix. A Ta film is formed over the transparent substrate 4 by a sputtering method and a signal input terminal 6 and a height control film 14 are formed by a photolithography method, which forms an element substrate 7. Since the height of an intra-seal spacer 11 is insufficient compared with a portion of the signal input terminal 6, the height control film 14 is formed to compensate for it.

[0015]

Orientation films 8 and 9 are formed opposed to each other by an offset printing

method over the transparent pixel electrodes 2 and 5, respectively. An intra-cell spacer 13 is sprayed by a dry spraying method between the opposite substrate 3 and the element substrate 7 to keep a cell gap uniform. A seal resin 10 enclosing the intra-seal spacer 11 having a uniform diameter intervenes in a peripheral gap between both the transparent pixel electrodes 2 and 5 by a screen printing method and covers the peripheral gap. At this time, an upper end of the seal resin 10 is in contact with the transparent substrate 1, and a lower end of the seal resin 10 is in contact with a top of the signal input terminal 6 and a top of the height control film 14. The thickness of the height control film 14 is made equal to that of the signal input terminal 6, and its error is kept 1000 Å or less. Thus, a pair of the transparent substrates 1 and 4 is parallel to each other with high accuracy. In other words, a gap between the pair of the transparent substrates 1 and 4 is kept uniform over an entire panel.

[0016]

The element substrate 7 and the opposite substrate 3 are pressed and attached at high temperature under high pressure, and an internal space surrounded by the transparent substrates 1 and 4 and the seal resin 10 is filled with a liquid crystal layer 12 by a vacuum injection method. An inlet used at the time of filling is coated with an ultraviolet curing resin, and is sealed by ultraviolet ray irradiation, thereby obtaining a finished article of a liquid crystal display panel.

[0017]

In forming the height control film 14 over the transparent substrate 4, a thickness thereof is controlled so that an error of a cell gap between both the transparent substrates 1 and 4, which is maintained by the intra-seal spacer 11 enclosed in the seal resin 10, is kept in the range of approximately 1000 Å on four sides. Consequently, non-uniformity of a cell gap on a display surface of a liquid crystal display panel is eliminated, and a liquid crystal display panel with high display quality, in which uneven contrast or an interference fringe such as Newton ring (NR) is not caused, were able to be obtained.

[0018]

Note that only a single layer of the height control film 14 is formed over the transparent substrate 4 on the element substrate 7 side in the above-described embodiment. However, it may also be formed over the transparent substrate 1 on the opposite substrate 3 side, or may be formed over both of them. Further, the height control film 14 may be formed by laminating a plurality of films. Although the black-and-white liquid crystal display panel is described in this embodiment, the invention can also be applied to a color liquid crystal display panel. Further, the ITO

film formed in a simple matrix is described as the transparent pixel electrodes 2 and 5 in the above-described embodiment. However, the transparent pixel electrode may be formed into an active matrix in which a thin film transistor (TFT) is formed into an array.

[0019] Embodiment 2

FIG. 2 is a perspective view showing an active matrix liquid crystal display panel according to Embodiment 2; FIG. 3, a three-dimensional circuit wiring diagram thereof; FIG. 4, an expanded sectional view along the line a-a of FIG. 2; FIG. 5, an expanded sectional view along the line b-b; and FIG. 6, an expanded sectional view along the line c-c.

[0020]

A Ta layer of 3000 Å is formed by a sputtering method over a matrix side transparent substrate 22 of a glass substrate or the like, and the Ta layer is formed into a linear shape by a photolithography method, thereby forming matrix side electrode lines 33 and 34. In addition, a signal extraction line 28 is formed into a linear shape having a width of 3 mm over the transparent substrate 22 in a similar manner. Silicon nitride (SiN_X) is formed as an insulating film 32 with a thickness of 4000 Å over the matrix side electrode lines 33 and 34 and the signal extraction line 28 by a CVD (Chemical Vapor Deposition) method. In this case, a necessary portion of the insulating film 32 over the signal extraction line 28 to be electrically connected to an opposite electrode 27 of an opposite transparent substrate 21 is removed by a photolithography method (FIGS. 4 and 6).

[0021]

An orientation process is performed on each of the matrix side transparent substrate 22 and the opposite transparent substrate 21. For example, a seal resin 23 in which a carbon particle having a uniform diameter of 7.0 μm of 5 to 20 % by weight is mixed as a conductive particle 37 is attached to the opposite transparent substrate 21 by printing or coating. On the other hand, a plastic particle of 5.0 μm is uniformly sprayed and attached to the matrix side transparent substrate 22 as an intra-cell spacer 25. Then, the transparent substrate 21 having the conductive particle 37 and the transparent substrate 22 having the intra-cell spacer 25 are attached to each other. With the seal resin 23 heated and cured, a liquid crystal layer 24 is injected from a liquid crystal inlet 35 to fill an internal space surrounded by the transparent substrates 21 and 22 and the seal resin 23, and then, the liquid crystal inlet 35 is sealed by a sealing resin 36.

[0022]

The conductive particle 37 having a uniform diameter which is mixed into the

seal resin 23 is welded with pressure to both the opposite electrode 27 of the opposite transparent substrate 21 and the signal extraction line 28 of the matrix side transparent substrate 22 as shown in FIGS. 4 and 6. Since the matrix side electrode lines 33 and 34 are covered with the insulating film 32, these are not electrically connected to the opposite electrode 27. On the other hand, as to the signal extraction line 28, the insulating film 32 is removed. Therefore, the signal extraction line 28 is electrically connected to the opposite electrode 27 through the conductive particle 37. A number of conductive particles 37 serve to electrically connect the opposite electrode 27 to the signal extraction line 28 and also to control an interval between both the transparent substrates 21 and 22. Therefore, the number of steps is reduced compared with a conventional example in which electrical connection and interval control are performed as different steps (a coating step of the electrical connection member 31 such as silver, Ni, or carbon in the line extraction portion 30 can be omitted). Production time can be shortened correspondingly, and productivity can be improved.

[0023]

Note that electric resistance of the signal extraction line 28 recorded 100 Ω according to measurement.

[0024]

Reference numeral 37 shown with three longitudinal lines in FIG. 3 denotes a conductive particle which connects the opposite electrode 27 to the signal extraction line 28. In addition, reference numeral 38 denotes a liquid crystal cell, and reference numeral 39 denotes a driving thin film transistor (TFT).

[0025]

[Effect of the Invention]

According to the first liquid crystal display panel of the present invention, a height control film is formed in a portion where the height of an intra-seal spacer is insufficient so as to keep a cell gap uniform over an entire panel. Therefore, a high quality display condition can be obtained, in which non-uniformity of a cell gap on a display surface is eliminated and uneven contrast and an interference fringe are not generated.

[0026]

Further, according to the second liquid crystal display panel of the invention, a conductive particle mixed into a seal resin serves to electrically connect transparent electrodes to each other and also to control an interval between both the transparent electrodes at the same time. Therefore, the number of steps is reduced compared with a

conventional example. Thus, production time can be shortened, and productivity can be improved.

[Brief Description of Drawing]

[FIG. 1] A cross-sectional view schematically showing a structure of a liquid crystal display panel according to Embodiment 1 of the present invention.

[FIG. 2] A perspective view showing an active matrix liquid crystal display panel according to Embodiment 2 of the invention.

[FIG. 3] A three-dimensional circuit wiring diagram of a liquid crystal display panel according to Embodiment 2.

[FIG. 4] An expanded sectional view along the line a-a of FIG. 2.

[FIG. 5] An expanded sectional view along the line b-b of FIG. 2.

[FIG. 6] An expanded sectional view along the line c-c of FIG. 2.

[FIG. 7] A cross-sectional view schematically showing a structure of a liquid crystal display panel according to a conventional example.

[FIG. 8] A perspective view showing an active matrix liquid crystal display panel according to another conventional example.

[FIG. 9] An expanded sectional view along the line d-d of FIG. 8.

[Explanation of Reference]

1......Transparent substrate

2......Transparent pixel electrode

3......Opposite substrate

4......Transparent substrate

5......Transparent pixel electrode

6......Signal input terminal

7......Element substrate

8,9......Orientation film

10......Seal resin

11......Intra-seal spacer

12......Liquid crystal layer

13......Intra-cell spacer

14......Height control film

21......Opposite transparent substrate

22......Matrix side transparent substrate

23......Seal resin
24......Liquid crystal layer
25......Intra-cell spacer
27......Opposite electrode
28......Signal extraction line
32......Insulating film
33......Matrix side electrode line
34......Matrix side electrode line
35......Liquid crystal inlet
36......Sealing resin
37......Conductive particle
38......Liquid crystal cell
39......Thin film transistor

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